KNOW YOUR SOIL

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Soil Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

KNOW YOUR SOIL

Pete Smith was a successful farmer. He made a good living off his land. His neighbors respected his judgment on almost any farm problem you can think of.

One day Pete bought another farm, and right away he had trouble. He decided to put a 17-acre field into alfalfa. He prepared, fertilized, and seeded the field just as he'd always done. The alfalfa came up; but then it just stopped growing. It turned yellow and didn't make a crop.

The alfalfa didn't grow because the soil in that field was wet and sticky right under the surface. Pete knew alfalfa couldn't grow under these conditions, but he hadn't known the soil was like that before he bought the farm.

A soil survey would have told Pete about this.

Then there was Tom Johnson, who lived in a new suburb. Tom decided to supplement his income by growing vegetables in his backyard. He had almost half an acre of nearly level ground behind his house. The soil looked fertile; so he went ahead.

But Tom found the soil soggy, clayey—impossible to plow. A month of dry weather passed, and he tried again. Still wet. Tom called the county agent and found out that his septic tank was causing the trouble. The soil was so tight that the liquid waste could not soak in. "Septic tanks nearly always cause trouble in that kind of soil," the county agent said.

There wasn't much he could do. He was so far from the city mains that it might be years before he could hook on. Enlarging the tank would not help, since the subsoil was practically impervious. This soil just wasn't the right one for a home needing a septic tank. Tom was in for trouble, not only with his garden but also with his sewage disposal system.

F—1092

An airplane flies over the survey area at about 12,500 feet while a special camera takes pictures at regular intervals. A soil scientist will use these aerial photographs to do his mapping.

IA—2747

A soil scientist marks the division between soil layers. He has given this soil a symbol and tentatively identified it as Madorlean loam.

And R. A. Helmer, Research Engineer for the Oklahoma Highway Department, tells how a county soil survey, which was made long after U.S. Highway 70 was built, showed that locating the highway not more than 1 mile away would have avoided plastic clay soil entirely and would have placed it on a sandy loam. Building this highway on the wrong kind of soil cost the taxpayers an extra $600,000.

"U.S. 70 crosses Choctaw County from east to west, a distance of 45 miles. About 13 miles was built on sandy loams. It takes an average of 15 inches of base and subbase for a highway on these soils. The other 32 miles were built on plastic clay soils. It takes an average of 26 inches of base and subbase on these soils—11 inches more than the sandy loams. By 1950 prices, an inch of paving costs about $1,800 per mile. Then 11 inches times $1,800 for 32 miles figures out to be more than $600,000."

What is a soil survey? How is it made? Who does it? Who uses it? How can you find out if your land has been surveyed? How can you get a soil survey report? The answers to these questions will fall into place as we outline the making of a soil survey.

Making the Soil Survey

Soil, in the general sense of the word, covers most of the land surface of the earth. A soil, in the specific sense used here, is one particular part of this cover in one particular place. A soil is three-dimensional. It is bounded on the top by the surface of the land, on the bottom by rock material, and on the sides by other soils. The first job of the soil scientist is to distinguish between these separate soils. He then classifies them, describes them in great detail, and maps them.

To make a modern soil survey, the soil scientist needs a set of aerial photographs that completely cover the area he's going to map.

These photographs are taken from an airplane flying at about 12,500 feet. With each pass across the area, the plane overlaps the previous pass, photographing part of the same landscape from a different angle. When a soil scientist looks at two of these overlapping photographs under a stereoscope, he can see three dimensions. Differences in elevation are sharply de-

OH—60730

A soil scientist examines the soil layers in a freshly dug pit and describes them in a notebook. The spikes in the bank mark the separate layers.

NEV–852; MO–1861; IDA–45194

The soil scientist uses a long spade, called a sharpshooter, when he needs to examine a soil carefully in its natural state. He uses augers when he needs to make deeper and more frequent examinations. A screw auger (middle) is good for picking up damp, clayey soils, but the scientist uses a bucket auger (bottom) when he wants to sample soils that are loose and dry. Augers are usually 3½ feet long, but they can be used with extensions to go much deeper.

fined; the hills and valleys are clearly seen. Even small buildings and trees stand up, while draws and canyons drop down. With the aid of a stereoscope, the soil scientist can draw tentative lines on the photographs at sharp slope breaks before he ever puts foot on the land.

With his special training and experience, the soil scientist can study the photographs, confer with colleagues, give the area a preliminary once-over, and thus come to know a great deal about the soils before he begins the actual field work.

For the field work, the soil scientist equips himself with the photographs (which he calls field sheets), a spade and a hand auger, and several devices for making on-the-spot tests. He is ready to map the soils.

He first walks over the ground and studies it. He bores or digs numerous holes, using a power auger in some places. Often, he takes advantage of recent excavations and bare roadbanks. Since a soil is made up of distinct layers, the soil scientist notes the texture, structure, color, and thickness of each one. He is especially alert to soil characteristics that you can't see from the surface—for example, hard subsurface layers that interfere with water movement and plant roots.

There are thousands of different kinds of soil, and the soil scientist has to measure or estimate the important properties of each soil in order to know for sure which kind he has. He estimates how fast water moves through the soil and how much will stay there. He measures the steepness of slope and estimates the amount of soil lost by erosion. He notes the depth of the rooting zone, the amount of organic matter, and the acidity or alkalinity.

He also marks the location of natural land features such as streams, rock outcrops, lakes, ponds, and marshes; and of man-made features such as levees, ferries, fords, churches, quarries, gravel pits, and cemeteries. These help the map reader locate soil boundaries in the field, many of which are not obvious on the surface. The soil scientist records this information by putting a symbol on the field sheet or by writing it out in his notebook.

As he goes, the soil scientist draws lines on the field sheets when he crosses from one soil to another. Some of these lines indicate abrupt changes, others gradual transitions. Where two soils merge, the soil scientist draws his line near the center of the transition belt.

When he has finished marking the field sheets, they look a bit like jigsaw puzzles. He identifies each piece of the "puzzle" with a symbol, and he uses the same symbol every time he finds the particular kind of soil.

The essential work of the soil survey is done here in the field by the well-trained, well-equipped soil scientist.

60731

A soil scientist checks the color of his soil sample against a chart.

CAL-6712

A soil scientist uses a piezometer to find out how far below the surface the ground water lies.

NEB-1909

A soil scientist measures the slope with a hand level.

LA-62577

After studying a soil and deciding what kind it is, the soil scientist draws its boundaries on an aerial photograph.

But he also sends soil samples to the laboratory for additional studies. These studies serve several purposes.

The soil scientist applies some simple techniques in the field that the laboratory can check for accuracy. For example, he judges texture by rubbing moist soil between his thumb and fingers. The laboratory can test his judgment by measuring exactly the percent of sand, silt, and clay in representative samples.

Laboratory work helps in classifying the soils by making the descriptions as precise as possible. For example, the laboratory can learn the distribution of certain important minerals by studying thin sections of a soil under the microscope.

Other laboratories of the cooperating State universities receive samples for making tests of available plant nutrients. The results help the farmer or gardener to develop an efficient fertilizer program.

When the soil scientist is mapping and describing a soil in the field, he places it tentatively in a class with other soils that have already been described, named, and mapped.

Through the National Cooperative Soil Survey, all soils are classified and named according to a national system. About 70,000 kinds are recognized now. In the field, the soil scientist fits each soil that he finds into this system. If the soil is a new one, he gives it a new name; and later on, the system is expanded to allow for a new soil. When he finds a new soil, the soil scientist gives it a local place name, such as "Chippewa" or "Miami."

All of this work is done cooperatively with the State agricultural experiment stations and with other State, Federal, and local agencies.

During the course of the survey, supervisory soil scientists check on the work to make sure it agrees with the national system of classification. Specialists in soil classification—soil correlators—have the job of studying the evidence compiled by the soil scientists in the field and of identifying soils in a new survey with similar soils already classified.

While doing his field work, however, the soil scientist is careful to make it as exact as he can. He writes his notes in standard terms and organizes them as he goes so that they may be used as an active reference during the rest of the survey. This means too that, at any time, the information he has collected is available to those who need it. When he has finished, the notes and the field sheets are used in writing a soil survey report for publication.

SC-D22-9

When spades and hand augers don't go deep enough, the soil scientist brings a power auger into play.

OH-60760

A soil scientist makes a simple test to determine the acidity of the soil.

MD-30324

A laboratory soil scientist checks soil samples for their proportions of clay, silt, and sand. He can verify or correct the surveyor's judgment on soil texture.

CAL–6754

An orchard farmer discusses his conservation farm plan with an SCS man. He has decided to put in contour irrigation.

The Soil Survey Report

When the soil survey for an area is complete, a report is published that includes the soil maps (usually at a scale of slightly more than 3 inches to the mile), names and descriptions of the soils shown on the maps, and statements about the suitability of the soils for various purposes. Recent reports have special sections for engineers.

Soil survey reports are published by the Soil Conservation Service in a standard series.

To find out whether a soil survey report has been published for your county and, if so, where you can find a copy, check with your county agent, the local Soil Conservation Service office, your soil conservation district, or your State agricultural experiment station. Soil survey reports can be purchased from the Superintendent of Documents, Washington 25, D.C. They may be seen in many libraries throughout the country.

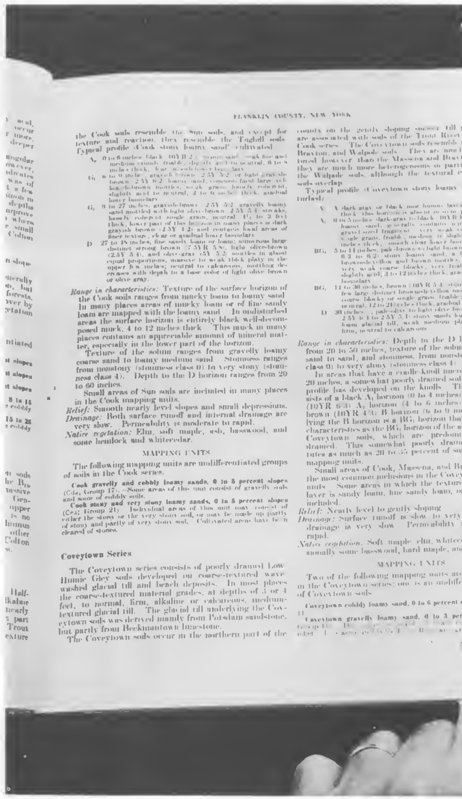
Using Soil Information

Soil information is useful to all people, directly or indirectly. Its importance to farmers, ranchers, and foresters has long been recognized, and now city people are beginning to realize how much influence it has on both their home life and their business. Some of the frequent users of soil information are land appraisers, realtors, builders, engineers, city planners, foresters, nurserymen, canners, pipeline manufacturers, and insurance companies.

Soil Information for Farmers

The primary purpose of making soil surveys is to provide for the Nation's agricultural future. The Nation cannot prosper without food; most food can come only from soil; soil has to be protected; protecting the soil is possible only with detailed information about it. Few soils produce economically just as they are. Many of our most productive soils have been made so through the farmer's art. Soil surveys provide the basic information for this work.

Almost all farmland in the United States is privately



The soil survey report includes a series of maps and a tex
enables the reader to correl

owned. So it's the owners themselves—nearly 4 million of them—who have to do the actual work of conservation. The job of the Soil Conservation Service (SCS) is to give them technical assistance based, among other things, on the soil survey.

Each farm, of course, has characteristics that the farmer won't change—simply because it isn't practical. For example, he won't move his barn just because he finds out the soil underneath it is good for growing cotton.

Or, a farmer might want to leave the trees near his

MD—30210

that describes each kind of soil. Here, the symbol Cfa
te the map with the text.

house standing, even though he could make money by cutting them down and planting corn.

The SCS man doesn't try to advise the farmer on decisions like these. His job is to help the farmer plan the use of his soil so that it will become productive and remain so. The farmer must make the decisions.

Planning the future of a piece of land is much like planning your own future. Some soils have few alternatives; for others they are almost numberless. But you don't make decisions at random. Through experience and education you develop certain standards for making your decisions.

Some of the standards that help a farmer make his decisions, in addition to the kinds of soil, are the size of the farm, the rainfall, and the potential market for his crops. Then, too, his skills, age, and desires influence his plans for the future. So do the actions of his neighbors.

The decisions he makes in developing a conservation plan fall into two categories: how the soil will be used and how it will be improved and protected. The first decision usually determines the second, but sometimes it's vice versa.

For example: the SCS man tells the farmer that he can safely plant corn in Field A every fourth year if he keeps it in grass the other 3 years to protect the soil from erosion. If he needs more corn, he will need to

MINN—1684

The farmer uses this gently rolling field within its capability as indicated by the soil survey. Alternating contour strips of corn and grass help protect the soil against rapid runoff and erosion.

use more practices. On sloping land the SCS man might suggest a terrace system. This slows runoff and thus cuts down on erosion. Now he can plant corn on the field every third year.

It might be cheaper, however, for him to drain the excess water from Field B, which is level and requires no terracing, and grow corn there. Or he might find that part of his pasture can be safely converted to corn without installing expensive terraces.

The possible combinations are almost endless. But the SCS man and the farmer will be able to develop a conservation plan because they share the same goals: conservation of the soil and a good living for the farmer. These goals are interdependent. Over a long period, neither one is possible without the other.

The information in a soil survey is interpreted in many ways, depending on the purpose. For farmers, soils may be grouped according to their suitability for grain, pasture, hay, and other crops; for range; for timber; for drainage; or for irrigation.

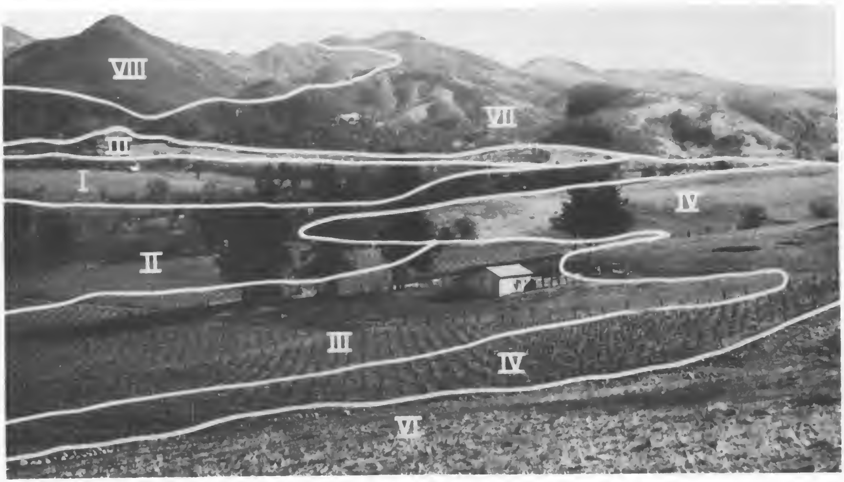
But the most widely used interpretation for devising a conservation farm plan is the "land-capability classification." Here, the individual soils are classified according to what they are capable of producing and according to the risk of soil damage if they are mismanaged.

There are eight broad capability classes, shown on land-capability maps by Roman numerals. As you go from Class I to Class VIII, your choices in use become fewer and the risks become greater.

Soils in Classes I through IV can be safely used for the common cultivated crops, which leave the soil bare part of the time. But as you go from Class I to Class IV your choices become fewer. Also, the conservation practices needed for these cultivated crops usually become more difficult to apply and to keep working efficiently. Actually, soils in Class IV are borderline for the common cultivated crops under present economic conditions.

Although they are not subject to erosion, soils in Class V are not suited to ordinary cultivation, usually because they are wet too much of the time, because they are too stony, or because the growing season is too short. But they can produce good pasture—or trees where there is enough rain.

Soils in Classes VI and VII are most safely used for some kind of permanent cover like grass or trees. They may be so steep, stony, wet, or shallow that they cannot be cultivated economically and safely. With very special management, including elaborate soil and water conservation practices, a few of them can be cultivated to special crops.



CAL-6571

This photograph illustrates several land-capability classes. As you go from Class I to Class VIII, your choices in use become fewer and the risks become greater.

TEX—46610

A farmer sprays concrete into a new irrigation ditch. Without this lining, some soils take in so much water that very little reaches its planned destination.

Class VIII land is not suited to any vegetative crop that can be sold. Usually it is very severely eroded or is extremely sandy, wet, arid, rough, steep, or stony. But it is useful for wildlife food and cover, for recreation, and for protecting the watershed.

The land-capability classes are useful in introducing the farmer to the more detailed information on the soil maps. This information allows him to decide how he is going to use each of his fields and what conservation practices each of them needs. The result is a conservation farm plan.

For areas that have special problems, the soil scientist supplements the survey information with additional tests. For example, soils that are strongly saline or alkaline require special management for reclamation. The soil scientist identifies soils that cannot be irrigated practicably and suggests methods for reclaiming those that can be used for crops.

Soil Information for Land Appraisers

Land appraisers have found that soil surveys provide excellent information on which to base land values. In many counties tax assessors have revised the tax base after a soil survey for the entire county has been made. Many counties share the cost of the mapping in order to speed up the work.

In one county soil survey information was translated to earning power through a system of corn-suitability ratings. Since corn was the main crop, it was decided that corn production would be used as the basis for determining a value for each tract of land. Scientists from the State experiment station and the U.S. Department of Agriculture helped develop ratings based on past yields of the different soils.

Efficient farmers have often complained that tax assessors are unfair to them, since their well-kept, improved farms are given higher valuation than rundown farms. Using a soil survey to help appraise land avoids such complaints, since the appraisal is based on the soil rather than on the outward appearance of the farms.

Such appraisals have proved popular with farmers. One assessor reported only one complaint after a new assessment was made based on the soil survey. Five years previously more than 1,500 complaints were filed.

Soil Information for Realtors, Home Builders, and Subdividers

Residential developers use soil information to determine what kinds of soil can be used for fills beneath foundations, for subgrades of roadways, for foundations of structures.

Since soil is disturbed by excavation, the structure of the soil is usually less important than the other characteristics. Amount of moisture is important since dry soil must be moistened for compaction and very wet soil requires expensive drainage.

SC—D27—31

Real estate developers consult a soil survey map as they look over the site of a new subdivision.

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Builders of the apartments on the right cut back the hillside too steeply, causing the unstable, gravelly soil to slip and cave in.

BN12938

This house was built on an unstable soil. The soil's swelling and shrinking with changes in the weather made the wall crack.

Developers can benefit greatly by studying soil maps and locating the soils that suit their purpose. Septic tank effluent does not filter through some soils that have a large proportion of clay. Unstable soils slip, making house foundations and walls crack. Some soils are subject to frequent flooding. Others are unsuitable for lawns and gardens unless the homeowner is willing to spend a great deal of time and money in improvements. Realtors, home builders, and subdividers can all profit greatly by knowing these things ahead of time.

Soil Information for Engineers

Engineers use soil surveys in judging sites for buildings, highways, airports, dams, and conservation structures.

For example, an engineer wouldn't want to use a porous soil to build a dam or a pond. And he wouldn't want to lay a highway on soil that swells or cracks when the weather changes.

Frequently, too, the kind of soil determines the engineer's design. Suppose he is cutting a highway through a hill. With most soils, he has to slope the banks to prevent landslides. But if he's working with loess in the Midwest, he cuts the banks almost vertically.

Soil surveys also tell engineers if a soil is able to support trucks or cars moving across an open field. This information is essential for both wartime emergencies and peacetime construction jobs.

If an engineer needs sand, gravel, or limestone the survey tells him where he can probably find it.

All of this information helps the engineer in making his own surveys. Because of the nature of his work, however, he needs information not only about the soil, as the soil scientist defines it, but also about the material that lies below. As a matter of fact, the engineer's definition of soil includes all underlying earth materials except solid bedrock.

And sometimes his purpose is the very opposite of the farmer's. While the farmer is usually concerned with making the soil take in as much water as possible, the highway engineer is concerned with keeping out as much as possible.

But both farmer and engineer are interested in the basic properties of the soil, so both can be helped by the soil survey.

Soil Information for Foresters

Foresters use soil survey information to decide what trees grow best on a particular kind of soil and what kind of conservation practices are needed.

These two major decisions rest on many variables: rate of growth; survival chances of the seedlings;

ND-603

The soil under this highway, built on a slope above the Red River, was unable to support the pressure. The highway could not be repaired and had to be reconstructed 150 feet further from the river.

IOWA HIGHWAY COMMISSION I-14-11

Cutbanks are almost vertical in the fine-grained loess soil of the Midwest. Most soils cave in if sloped at such a severe angle.

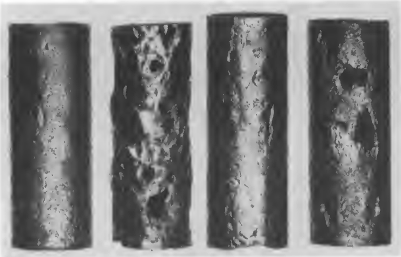
A sheepsfoot roller compacts the soil on a highway fill. Engineers use soil information in locating and designing roads.

BUREAU OF PUBLIC ROADS

Concentration of water causes some soil to slip. The alternatives are to make the slope more gentle or to divert water from the hillside above.

BUREAU OF PUBLIC ROADS

Shrinking of the soil underneath this gutter is due to the tree's absorption of water. The only solution is to remove the tree. Soil surveys can tell prospective builders about such problems.



NATIONAL BUREAU OF STANDARDS 26748

Some soils corrode metal pipes. These steel sections were buried for 14 years in four different kinds of soil. One is almost intact, while the others show different degrees of corrosion.

growth of competing plants; physical problems of managing and harvesting the trees; possibility of windthrow during storms; dangers from erosion, disease, pests, and insects; and the value of the soil for special products, such as maple sirup, Christmas trees, and turpentine.

Each of these varies according to the particular combination of tree and soil, and each influences the forester's final decisions.

Soil Information for Others

Farmers and ranchers, realtors and builders, engineers, foresters, and land appraisers are by no means the only people who need and use information about soils.

Other groups representing a variety of interests need information that soil surveys provide. Many of them need help in interpreting the facts for use in their specialized fields. The Soil Conservation Service gives this help where possible and encourages the groups themselves to employ soil scientists when the amount of work will justify it.

Within recent years metropolitan planners have come to need and use soil information that is vital to their job. Fairfax County, Va., is an example. So great has been the demand for soil information for a wide range of uses, including location of roads, septic tanks, shopping centers, schools, foundations for large buildings, underground utilities, that the county supervisors appropriated money to help complete the soil survey started by the Soil Conservation Service and the Virginia State Agriculture Experiment Station. And they hired a soil scientist themselves. He and the county health officer ran percolation tests on more than 1,000 soil sites in the county. Today, the soil must be suitable or the septic tank cannot be approved.

The county planning commission and zoning board examine a soil map and consult the soil scientist before making decisions about zoning, whether for residential, commercial, or public use. The soil scientist devotes all his time to interpreting the soil survey for the various government agencies and citizens of the county.

Fairfax County is but one of hundreds of counties with this kind of problem.

Some soils corrode pipes, and the Bureau of Standards estimates the annual cost of pipe line corrosion at $6 million. The Bureau has published important guides, geared to the standard soil classification. Oil and gas companies are now using soil information to prevent or cut down corrosion.

Soil information helps canneries and other food processors locate their plants. Are the nearby soils suitable for growing sweetcorn, peas, strawberries, tomatoes, beans? Soil facts provide the answers.

Investors, banks, insurance companies, and building and loan companies find soil surveys helpful in determining the soundness of proposed investments in land. Anyone who plans to buy a farm should look first at the kinds of soil and their potential productivity.

Manufacturers of earth-moving equipment need soil information for the design of certain types of machin-

When oil and gas companies dig ditches for laying pipelines, soil information is helpful in preventing corrosion of the pipes and erosion of the soil.

VT-804

A saturated and unstable layer of clay under the surface of this highway caused a bad slump. Soil surveys can help road builders discover these danger areas.

ery. The points of plows, blades of scrapers, and other similar machines are affected by the amount of sand and gravel in the soil; they must sometimes be designed to allow for excessive wear.

Soil conservation districts, watershed organizations, and drainage districts need soil information in doing their work. A soil survey forms the foundation for a soil conservation district's work by showing where in the district work is first needed, as well as what kind of program will be most beneficial.

Research workers in experiment stations use soil information to set up crop and fertilizer studies. Agronomists use soil data to predict responses to different kinds of management. Extension workers and teachers use soil maps to help farmers and students understand farming better.

Wildlife conservationists find soil surveys helpful in establishing wildlife areas; in building ponds and dugouts for fish, ducks, and geese; and in locating recreation, hunting, and fishing sites.

Even if you are in none of these professions, soil surveys are important to you. The information that they provide profoundly affects the economic life of every American.

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